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APPLICATION

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TITLE: **UNSYMMETRICAL PROFILE THREADS FOR USE IN A POSITIVE DISPLACEMENT MOTOR HOUSING**

APPLICANT: **Anmol KAUL**

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UNSYMMETRICAL PROFILE THREADS FOR USE IN A POSITIVE DISPLACEMENT MOTOR HOUSING

FIELD OF THE INVENTION

The invention relates to mud driven motors used in the drilling of oil wells. More particularly, the invention relates to an unsymmetrical thread profile for connection of a positive displacement motor (PDM) housing.

BACKGROUND OF THE INVENTION

Positive Displacement Motors (PDMs) are known in the art and are commonly used to drill wells in earth formations. PDMs operate according to a reverse mechanical application of the Moineau principle wherein pressurized fluid is forced though a series of channels formed on a rotor and a stator. The channels are generally helical in shape and may extend the entire length of the rotor and stator. The passage of the pressurized fluid generally causes the rotor to rotate within the stator. For example, a substantially continuous seal may be formed between the rotor and the stator, and the pressurized fluid may act against the rotor proximate the sealing surfaces so as to impart rotational motion on the rotor as the pressurized fluid passes through the helical channels.

Figure 1 shows a conventional downhole motor assembly known in the art. As shown, the assembly 10 includes a rotatable drill bit 12, a bearing/stabilizer section 14, a transmission section 16 which may include an adjustable bent housing (for directional drilling), a motor power section 18, and a motor dump valve 20. The bent housing 16 and the dump valve 20 are not essential parts of the downhole motor. As mentioned

above, the bent housing can be used as a means of directional drilling. The dump valve can be used to allow drilling fluid to enter the motor as it is lowered into the borehole and to allow drilling fluid to exit the motor when it is pulled out of the borehole. The dump valve also shuts the motor off when the drilling fluid flow rate drops below a threshold. During operation, drilling fluid pumped through the drill string (not shown) from the drilling rig at the earth's surface enters through the dump valve 20, passes through the motor power section 18 and exits the assembly 10 through the drill bit 12.

Prior art Figures 2 and 3 show details of the power section 18 of the downhole motor. The power section 18 generally includes a housing 22 which houses a motor stator 24 within which a motor rotor 26 is rotationally mounted. The power section 18 converts hydraulic energy into rotational energy by reverse application of the Moineau pump principle. The stator 24 has a plurality of helical lobes, 24a-24e, which define a corresponding number of helical cavities, 24a'-24e'. The rotor 26 has a plurality of lobes, 26a-26d, which typically number one fewer than the stator lobes and which define a corresponding plurality of helical cavities 26a'-26d'. Generally, the greater the number of lobes on the rotor and stator, the greater the torque generated by the motor. Fewer lobes will generate less torque but will permit the rotor to rotate at a higher speed. The torque output by the motor is also dependent on the number of "stages" of the motor, a "stage" being one complete spiral of the stator helix.

Stator housings of a PDM are typically connected with threaded connections. The threaded connections are particularly susceptible to bending stress fatigue failures. In

part, such failures result because the wall thickness of these housings is typically smaller than that commonly found on the connections of drill collars.

Accordingly, there is a need for a thread profile that reduces the stator housings' susceptibility to bending stress fatigue failures.

SUMMARY OF INVENTION

In one aspect, the present invention comprises an unsymmetrical thread profile used to connect stator housings of a positive displacement motor. The unsymmetrical thread profile comprises one or more load bearing flanks angled with respect to the longitudinal axis of the thread profile at a first angle. The unsymmetrical thread profile further comprises one or more non-load bearing flanks angled with respect to the longitudinal axis of the thread profile at a second angle. The unsymmetrical thread profile further comprises a root radius between the non-load bearing blanks and the load bearing flanks. The second angle is less than the first angle such that the root radius is greater than the root radius of a symmetrical thread profile having substantially the same pitch and first angle.

In another aspect, the present invention provides a method of providing a larger root radius for a thread profile. The method comprises providing a load bearing flank having a first angle and providing a non-load bearing flank having a second angle less than the first angle.

In another aspect, the present invention provides a method of reducing the fatigue experienced by a threaded connection comprising reducing the angle of the non-load bearing flank to increase the root radius.

Other aspects and advantages of the invention will be apparent from the following description and the appended claims.

BRIEF DESCRIPTION OF DRAWINGS

Figure 1 is a side elevation view of a prior art drilling motor assembly;

Figure 2 is a cutaway view of the motor of Figure 1 showing the rotor and the stator;

Figure 3 is a cross section taken along the line 3-3 in Figure 2;

Figure 4 shows a prior art thread profile used to connect stator housings of a positive displacement motor.

Figure 5 shows an enlarged view of a prior art stator housing threaded connection.

Figure 6 shows an embodiment of the thread profile of the "pin-side" threaded connection of the present invention.

Figure 7 shows an enlarged view of an embodiment of the thread profile of the present invention.

Figure 8 shows an embodiment of the thread profile of the "box-side" threaded connection of the present invention.

Figure 9 shows an enlarged view of an embodiment of the thread profile of the present invention.

DETAILED DESCRIPTION

Figures 4 and 5 show a prior art conventional thread profile 30 that is used to connect stator housings of a positive displacement motor (PDM). Figure 4 shows the threaded connection 32 on the pin-side 34 of the stator housing 36, while Figure 5 shows an enlarged view of the threaded connection 32. As used in this application, the term "pin-side" refers to the end 34 of the stator housing 36 that is threadably received by the "box-side" 38 of the adjacent housing/drill string component 40.

The illustrated conventional thread profile 30 of the threaded connection 32 is a tapered thread with a symmetrical V-profile and a symmetrical root radius 42. The thread root radius 42 governs the stress concentration and the level of fatigue resulting from the bending and axial stresses experienced in the threaded connection 32 during the drilling process. For a given pitch diameter and profile angle, the root radius 42 is limited by the useful mating area and the thread pitch P.

Figures 6 and 7 show an embodiment of the thread profile 44 of a threaded connection 46 of the present invention. The threaded connection 46 is adapted for the connection of the stator/adapter housing 48 of a PDM. Figure 6 shows the threaded connection 46 on the pin-side 50 of the stator/adapter housing 48, while Figure 7 shows an enlarged view of the threaded connection 46. As best seen in Figure 7, the

embodiment of the thread profile 44 of the present invention is shown in solid lines that overlay the conventional thread profile 30 that is indicated by the dashed lines.

As shown, the thread profile 44 of the present invention is unsymmetrical. The resulting profile 44 provides for a larger thread root radius 52 than the root radius 42 provided by the conventional prior art design. Because the thread root radius 52 governs the stress concentration and the level of fatigue of the threaded connection 46 experienced under bending and axial stresses, the larger root radius 52 acts to reduce the susceptibility to fatigue failure of the threaded connection 46. The same is accomplished by reducing the angle of the non-load bearing flank 54 of the threaded connection 46. In this way, the load bearing area and pitch P of the threaded connection 46 is maintained while a larger root radius 52 is provided. Accordingly, the make-up parameters, such as torque carrying capacity of the threaded connection 46, remain unaffected while the fatigue failure susceptibility is reduced.

Figures 8 and 9 show an embodiment of the thread profile 56 of the threaded connection 58 of the present invention wherein the thread profile 56 is adapted for use on the box-side 60 of the stator/adapter housing 62. Figure 8 shows the box-side 60 of the stator/adapter housing 62, while Figure 9 shows an enlarged view of the threaded connection 58. As best seen in Figure 9, the embodiment of the thread profile 56 of the present invention is shown in solid lines that overlay the prior art conventional thread profile 30 that is indicated by the dashed lines.

Similar to the above discussion regarding the thread profile 44 for the threaded connection 46 on the pin-side 50 of the stator/adapter housing 48, the thread profile 56 on the box-side 60 is unsymmetrical. The resulting profile 56 provides for a larger thread root radius 64 than the root radius 42 provided by the conventional prior art design. Because the thread root radius 64 governs the stress concentration and the level of fatigue of the threaded connection 58 experienced under bending and axial stresses, the larger root radius 64 acts to reduce the susceptibility to fatigue failure of the threaded connection 58. The same is accomplished by reducing the angle of the non load-bearing flank 66 of the threaded connection 58. In this way, the load bearing area and pitch P of the threaded connection 58 is maintained while a larger root radius 64 is provided. Accordingly, the make-up parameters, such as torque carrying capacity of the threaded connection 58, remain unaffected while the fatigue failure susceptibility is reduced.

While the invention has been described with respect to a limited number of embodiments, those skilled in the art, having benefit of this disclosure, will appreciate that other embodiments can be devised which do not depart from the scope of the invention as disclosed herein. Accordingly, the scope of the invention should be limited only by the attached claims.